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THE BOTANICAL GAZETTE

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In the August number will appear:

Notes on the flora of Chicago and vicinity; by E. J. HILL, *Englewood, Chicago.*

On Amaranthus crassipes; by JOHN M. HOLZINGER, *Dep't of Agriculture, Washington, D. C.*

On the relation of certain fall- to spring-blossoming plants. II.; by AUGUST F. FOERSTE, *Cambridge, Mass.*

On the development of the embryo-sac in Arisæma triphyllum; by DAVID M. MOTTIER, *University of Indiana, Bloomington.*

BOTANICAL GAZETTE

JULY, 1892.

On the genus Lindbladia.

GEO. A. REX.

The genus Lindbladia of the Myxomycetes, is represented by a single species only. This species, *Lindbladia effusa* (Ehr.) Rost., has a wide range in the United States, having been found in one or the other of its forms in several of the middle and western states. The genus and species have been described by Rostafinski as follows:

LINDBLADIA Fr.—Æthalium naked, composed of numerous irregularly polygonal, minute sporangia with the walls grown together; surface to the extremities of the sporangia warted. —Rtfki. Mon. 223.

LINDBLADIA EFFUSA (Ehr.) Rostfki.—Æthalium naked, seated on a common, strongly developed hypothallus; cortex when prematurely dessiccated black, thick, brown, lustrous, with the surface rough; mass of spores brown-ocher or umber; spores bright colored, smooth .0058–.0072 mm. diam.—Rtfki. Mon. 223. Cooke, Myxomycetes of Great Britain.

Unfortunately the brief diagnostic description of Rostafinski as given above, and also in the *Sylloge Fungorum* of Saccardo, only covers in reality a comparatively small portion of the forms which are legitimately included within the limits of the species. The explanatory notes, however, which accompany this diagnosis in the *Monografia Sluzowce*, give a supplementary description of the more complex æthalioid forms, to which belong a large portion of the American specimens of Lindbladia, and also such European specimens as I have had the opportunity of examining.

An analysis of all American specimens will show a surprisingly varied series of forms, all of which may be properly classed under the one species. Although these are different in their external appearance, they possess the same morphological details.

In addition to the true æthalioid forms described by Rostafinski and others, a form with simple sometimes substipitate sporangia is found in all sections of the northern United States, which, for many reasons, is worthy of varietal distinction. It may be described as follows:

Var. **simplex** var. nov.—Sporangia simple, gregarious, either free and separate or crowded and touching each other but with the walls not grown together; standing in effused clusters on a common hypothallus; elongated ellipsoidal in shape or distorted by crowding; usually either sessile with a narrow base, or substipitate attached to the hypothallus by a black plasmodic point of attachment, or occasionally stipitate with well marked short brown-black rugose stipes; entire sporangia averaging one mm. in height. Sporangium walls simple, sometimes lustrous, often having a few longitudinal folds in their lower half, pale umber colored, roughened externally by being thickly studded with rounded dark-brown plasmodic granules; spores in mass pale umber colored, from 5.5—7.5μ in diameter, with thin epispores very delicately warted but apparently smooth under lenses of medium power.—*Perichæna cæspitosa* Pk.; no. 2,700 N. Am. Fungi, E. & E.

Common in the northern and western states. Stipitate form found in Shawangunk Mts., N. Y.

The occurence of stipes in this variety of the species, which has hitherto been described as æthalioid only in character, is a point of great interest.

Undoubtedly, the extreme forms of the species are apparently very diverse, there being a great range between the simple variety above described and the thick effused æthalia often found, although the area of hypothallus covered by the sporangia is as great in one case as in the other.

The morphological characters common to all these forms, however, are so positive that it is not possible to separate even the extremes by a valid specific distinction.

The æthalia vary greatly in thickness and structure, and may have either a naked or corticate surface. The simplest form of æthalium is composed of irregular or polygonal sporangia, standing in a single rank on a common hypothallus, with the lateral walls grown together, the upper surface being roughened with the dark brown plasmodic granules. These simple æthalia grade into other and more complex forms of æthalia, which grow in effused or sometimes hemispherical

patches often three quarters of an inch thick, and in the first case many square inches in diameter. They are formed of entangled or interwoven masses of elongated or branched sporangia with the walls grown together.

Some of these æthalia have the upper surface irregular and naked, formed simply of the convex apices of the component sporangia. Others have a nearly plane upper surface composed of a thick cortex, developed from and upon the apices and external portions of the sporangia. The special character of the æthalia, whether naked or corticate, seems to be determined by environment or by conditions affecting the plasmodium during its differentiation into sporangia. It is not in any degree dependent upon the size of the mature æthalium, for I have seen both of these forms of the maximum thickness attained by the species.

The spores of all forms, simple and æthalioid, are identical, being delicately warted under high power lenses. The hypothallus of all forms and the cortex of the corticate æthalia are composed of thick plasmodic membranes containing irregular particles of plasmodic refuse.

The hypothallus has an irregular laminated structure, composed of a varying number of thin membranous layers. In the simple variety it is a nearly uniform membrane being at most composed of but two or three layers. In the æthalia however the layers are numerous, not closely touching each other at all points, but separated at intervals, leaving sometimes quite large and wide interspaces which give the hypothalli a loose open structure. In the hemispherical æthalia it may form a sponge-like expansion of one-quarter to one-half an inch in thickness, upon which the branched and interwoven sporangia are erected.

The plasmodic colored granules which are found in the sporangium walls of all specimens of Lindbladia, are exceedingly interesting when examined under a high power lens, and are worthy of careful study. The exterior walls of both the simple variety and the naked æthalia, are thickly studded with these granules which are deeply colored with a violet-brown pigment. They are irregularly spheroidal in shape, averaging about 1.15 μ in diameter. They are composed of a plasmodic investing membrane continuous with the wall of the sporangium, which encloses a rounded nuclear mass also plasmodic in structure, but of a different density and refractive quality.

They project outwardly from the sporangium wall and are attached to its outer surface so slightly as to be readily broken off, leaving a ring-like base, thus giving the membrane of the wall the appearance of being covered with minute elevated annular markings or sculpturings.

Plasmodic granules similar in structure, but flattened and unpigmented, having been modified by their conditions, are found imbedded in the septa or dividing walls between the component sporangia of all the æthalioid forms, corticate as well as naked.

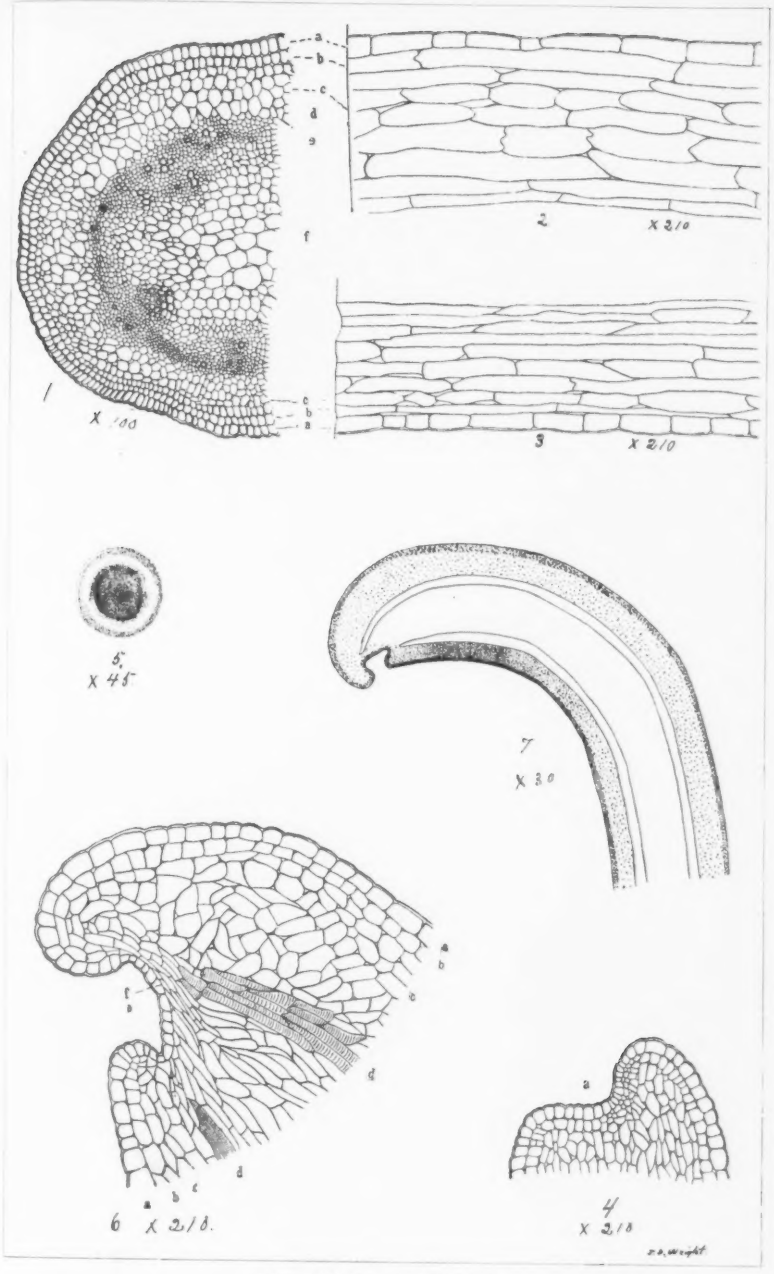
The various reagents which may be used in the preparation of the sporangium wall for microscopic examination, as for instance, alcohol and acidulated water, or the glycerine media used for permanent slide-mounts, will also develop the same annular markings, by softening and disintegrating the thin investing pellicle of the granules, thus freeing the denser nuclei which are comparatively unaffected by the reagents. This fact suggests the possibility of error in conclusions drawn from examinations made from mounted material only.

The natural relations of closely allied genera to each other will always prove an interesting and profitable subject for study, and the relations of Lindbladia and Tubulina, both genera belonging to the same order, LICEACEÆ, will serve as a striking illustration of this point.

The genus *Tubulina* shows an analogous and nearly parallel course of development to Lindbladia, in a series of forms also beginning with simple, separate, aggregated sporangia on a common hypothallus, and extending through various similar æthalioid forms; always however having the sporangia in a single rank, and finally even developing in some instances a partial cortex. At one point of the parallel development of the two series, the analogy is so great that the corresponding forms, if considered by themselves, would be properly classed as species of the same genus, the generic characters being so similar.

Yet Lindbladia, especially through its simple variety, more nearly resembles in some important structural characters the order HETERODERMEÆ through its genus *Cribraria*, than it does the analogous genus Tubulina of its own order.

These special points of correspondence are first, the existence of plasmodic colored granules throughout the whole



MacDOUGAL on TENDRILS.

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genus Cribraria (in common with the rest of the Heterodermeæ), similar in construction to those of Lindbladia except that they are permanent and not evanescent under the conditions above detailed; second, the similarity of the sporangia of at least one species, *Cribraria argillacea*, with its practically permanent wall, to those of the stipitate and substipitate forms of Lindbladia effusa var. simplex.

It is, therefore, a legitimate inference, that Lindbladia and Tubulina, although they closely approach each other, having been similarly developed along parallel ordinal and partially parallel generic lines, probably arose from independent and perhaps widely separated points of origin.

Philadelphia, Penn.

The tendrils of Passiflora caerulea.

D. T. MAC DOUGAL.

(WITH PLATE XIV.)

I. Morphology and anatomy.

The work recorded in this first paper was undertaken for the purpose of determining the factors in the movements of the tendrils of the Passifloræ, more particularly the movements by which a tendril responds to a stimulus, resumes its original position, or on continuance of the irritation coils permanently, and its subsequent changes while coiled and serving as a support for the weight of the adjacent part of the plant body.

Accepting as entirely tenable the view that the other movements of the tendril are the results of conditions of growth and varying states of turgescence, they will be considered only in so far as they affect the coiling of the organ. With this end in view, attention will be directed to the arrangement of the tissue systems, their relative mechanical value as determined by the structure of the individual cells composing them, the continuity of the protoplasm between cells of similar and dissimilar tissues with reference to the irritability and power of conducting impulse of the parts concerned, and to the physiological changes induced in the motile cells by the stimuli to which this organ responds.

The first investigations on the nature of tendrils of which we have any record are those of Palm[1] and Mohl[2] published within a few weeks of each other in 1827.

The descriptions in these works are necessarily very meager; the one dealing with the subject from a physiological standpoint while the other reasons from the structural characters alone.

In 1858 Prof. Asa Gray published his paper on the movements of the tendrils of the cucurbitaceous plants [3] which led Darwin to undertake a series of observations which he finally extended to more than one hundred species, the results of which were published in the Journal of the Linnean Society 1865. [4]

Hugo de Vries in his "Zur Mechanik der Bewegung von Schlingpflanzen"[5] deals chiefly with the difference of growth of the upper and lower sides of tendrils and the mechanism of movement of twining plants. All of these workers were concerned chiefly with the outward phenomena of movement rather than morphological changes and structural condition. Contemporaneous with these observers and later, much notable work has been done on the organogeny, structure and physiology of tendrils.[6]

To determine the conditions prevailing in the tendril during its period of sensitiveness it was thought necessary to study

[1] PALM: Ueber das Winden der Ranken. [2] MOHL: Ueber das Winden der Ranken und Schlingpflanzen.

[3] Proc. Amer. Acad. of Science and Arts.

[4] Climbing plants.

[5] Arbeiten des botanischen Institut in Würzburg, 1873, Band I. Heft 3.

[6] BRAVAIS BROTHERS: Annales Sc. Nat. 2 Sér., 1837.—ST. HILAIRE: Leçons de Bot. p. 170. 1841.—DUTROCHET: Comptes rendus. tom. 17. p. 989, Des mouvements revolutifs spontanes, 1843.—SACHS: Lehrbuch der Botanik; Physiology of Plants. —WYDLER: Flora 1853, Pringsheim's Jahrb. 1878, tome 2, page 317.—FRITZ MUELLER: Journal of the Linnean Society, vol. 9.—DE CANDOLLE: Bulletin de la Soc. Bot. de France, 1857 —LEON: *ibid* tom. 5, p. 680, 1858; Gardeners Chronicle 1864, 721, quoted from Darwin.—MCNAB: Trans. Bot. Soc. Edinburgh, vol. 2, page 292.—LOTAR: Essai sur l'anatomie comparée des Cucurbitacèes, Lille, 1871.—SCHWENDENER: Das mechanische Princip im anatomischen Bau der Monocotylen, 1874.—EICHLER: Blüthendiagramme, 2 vol. 1879.—DUTAILLY: Assoc. franc. pour l'Avanc. des Sc., 8 session: Recherches sur les Cucurb. et les Passiflores, 1879.—HABERLANDT: Physiologische Pflanzenanatomie.—VINES: Physiology of plants, 1886; La Sensibilitie et la motilitie.—MORREN: Des Veg. Bruxelles 1885 p. 52.—OTTO MUELLER: Untersuchung über die Ranken der Cucurbitaceen, 1886, in Cohn's Beitræge zur Biol. der Pflanzen —PENHALLOW: Mechanism of movement of Cucurbita, Vitis, and Robinia. Proc. Roy. Soc. Canada, vol. 4, sec. 4, 1886.—PFEFFER: Zur Kenntniss der Kontaktreize; Untersuchungen aus dem bot. Inst. zu Tübingen, Band I, 1885.—RUSSELL: Recherches sur la Vrille des Passiflores: Bulletin de la Soc. Bot. de France, 189, 1890.—MASTERS: Trans. Linnean Soc., 1878, p. 317.

its development through all stages of growth from the time of its appearance as an axillary papilla till it passed out of the sensitive stage. During the latter periods of growth sections could easily be made with the aid of pith and a common hand clamp and the collodion embedding method,[7] while in the younger stages a modification of the paraffin methods given by Moll, Campbell and Andrews in the BOTANICAL GAZETTE[8] was found to be more satisfactory.

The greatest difficulty, however, was experienced in fixing and hardening the material. The whole organ is in a state of extreme tension and the contact of any reagent on the sensitive concave surface will, unless it has sufficient strength and penetrative power to kill and fix the protoplasmic body instantly, cause the tendril to roll up in a helix, and the form of the wall and contents of the motile cells would be much distorted. A wide range of reagents was tried with but partial success in any case. Alcohol in strengths varying from 1 per cent. to 96 per cent. was found to be useless, as also corrosive sublimate. Potassium nitrate was found to give the best results in a 4 per cent. solution, but caused the organ to form an open helix. Chromic acid distorted the protoplastic structure besides rendering the sections difficult to stain. Schulze's chrom-acetic-osmic solution was useful only in tendrils less than 2 mm. in length. A mixture of one part distilled water and one part saturated solution of bichromate of potassium retained the structures fairly well in many cases, as did also weaker solutions of the same.

By far the best results were obtained by the use of acetic alcohol of the following composition: 1 part glacial acetic acid; 6 parts absolute (or 96 per cent.) alcohol; 3 parts chloroform.[9]

The tendril must be carefully cut from the stem with the least possible jarring and avoiding all contact with the sensitive lower surface, and then placed in the fixative which must be in a vessel of sufficient dimensions to receive its entire length in a horizontal position. The action of the fluid will cause it at first to curve slightly, and then to regain its former position. After two or three oscillations of this sort it will regain and keep nearly its original form. After remaining in this fluid for a time varying from 20 to 30 minutes, it was re-

[7] Proc. Am. Soc. of Microscopists, 1890. THOMAS: Botanical Gazette, Nov. 1890.

[8] January and June, 1888; July, 1890.

[9] LEE: Microtomists Vademecum, 1890.

moved, cut into convenient lengths and placed in 96 per cent. alcohol which was changed several times to remove the acid.

Sections were made with a Cambridge rocking microtome, fastened to the slide in series and after the removal of the paraffin stained in a hæmatoxylin-eosin mixture of the following composition: distilled water, 5 parts; hæmatoxylin (Delafield's) 3 parts; eosin (watery solution) 2 parts. The sections were allowed to remain in the staining fluid 20 minutes. After dehydrating and clearing they were mounted in Canada balsam dissolved in oil of cajeput. The differentiation afforded by this stain can hardly be excelled. The nuclear structures take a dark purple color while the remainder of the cell contents and the walls take on various shades of red according to density.

The tendrils of Passiflora cærulea are filamentous organs springing from the axils of the leaves, often reaching a length of 30 cm., tapering from a diameter of 2 mm. at the base to 1 mm. at the tip before coiling. When 1–3 cm. in length the whole surface often has a reddish purple tinge due to color bodies in the subepidermal cells. With growth the color becomes less vivid and is distributed over the surface in ill defined longitudinal bands. It often disappears entirely from the lower surface, being hidden by the deeper tinge of the chlorophyll.

The tendril makes its appearance as a cone of meristem tissue on the side of the growing point in the axil of a leaf. Shortly after its appearance while it is yet less than .5 mm. in length, there is formed on its summit an irregular cup-shaped depression (fig. 4) by reason of the excessive growth in length of the periblem, that of the upper side being greater. The continuance of this unequal growth causes the cup in the full-grown tendril to become lateral (fig. 5). About the time the cup has assumed the form in fig. 4, spiral vessels make their appearance just below it, followed by companion and sieve cells. The point of most rapid growth passes backward with the elongation of these fibrovascular elements until at the time of coiling it is found at a short distance below the middle of the organ.

When the tendril has reached this stage three distinct regions may be distinguished: the base or non coiling part, 3–4 cm. in length; the middle region or coiling portion comprising the greater part of the organ, which is generally slightly curved; and the sharply curved or hooked tip, 4–6

mm. in length. These three regions show some well marked differences in structure and outline. The whole organ shows a bilateral organization which is least apparent in the base and most pronounced in the portion having the greatest power of movement, a recognized correlation given by Dr. Otto Müller.[10]

The basal portion is broadly oval in outline with just a trace of flattening on the lower side; the middle portion is oval with its lateral much greater than the transverse diameter, while the lower surface is distinctly flattened. The tip is nearly circular in outline, and bears at its extreme end the cup-shaped formation above mentioned. Along the convex upper and lateral sides of the tendril are several obscure angles which are mostly absent from the lower concave surface.

The internal structure of these parts shows corresponding differences. The arrangement in the middle portion is as follows: The epidermis consists of a layer of rectangular cells with the longest diameter parallel to the long axis of the tendril (figs. 1, 2, 3, *a*). Occasional stomata are found distributed equally over both surfaces.[11]

Beneath the epidermis is a layer of collenchyma with thickenings so disposed that that the tangential are much heavier than the radial walls (figs. 1, 2, 3, *b*). Scattered through this tissue are the color bodies mentioned above. At the obtuse angles of the tendril this layer is three cells in thickness, at other places it decreases to one.

Internal to this is a layer of loosely arranged thin walled parenchyma of varying size, containing in the outer rows of cells an abundance of chlorophyll and protoplasm (figs. 1, 2, 3, *c*). The inner rows of cells bordering on the bast are richly loaded with starch, constituting the starch layer of Sachs.[12]

Through the entire layer are occasional crystals of calcium oxalate. The cells of this layer on the convex side are uniformly larger than those on the concave side, leading to a corresponding difference in thickness of the layer. The in-

[10] "Soweit also die Ranke central gebaut ist, zeigt sie kein Krummungsvermögen: soweit sie bilateral gebaut ist, soweit betheiligt sie an den Einkrummungen." l. c., p. 120.

[11] PFEFFER: Zur Kenntnis der Kontaktreize, Par. 9.

[12] Physiology of Plants, p. 358; STRASBURGER: Das botanische Practicum, p. 132.

tercellular spaces are large and plentiful by reason of the peculiar manner of junction of conical ended cells. In many cases, however, the entire ends of adjacent cells are pressed closely together, presenting the phenomenon (seen in figs. 2 and 3, *c.*) of one cell sending a protrusion into the cavity of another. It is evident that these cells by both structure and arrangement are well fitted to undergo great variations in size, while the large intercellular spaces, affording plentiful space for the reception of expelled cell sap, make possible rapid changes in the tension of this tissue. The parenchyma is connected with the central pith by medullary rays, two to four cells in height, in the region of secondary growth.

Immediately internal to the starch sheath is the bast region consisting of thin walled, closely packed cells, containing a large amount of dense protoplasm. These are in a condition of rapid growth which gradually becomes less active as the tendril approaches maturity, when they take on excessive wall thickenings, in a manner very similar to that of Cucurbita (fig. 1, *d.*).[13] When the tendril has only reached a fraction of its length this tissue has formed a continuous band interrupted only by the medullary rays.

About the time of maturity the cambium makes its appearance and soon forms a ring of secondary growth on the inner side of the bast, and retains its activity even after the coiling. The primary xylem elements (fig. 1, *e*) are about ten in number; half are disposed in a nearly straight row across the concave side, while the remainder are in an approximate semicircle to conform to the outline of the convex side. Each bundle consists of two or three spiral vessels arranged radially (with generally an annular vessel placed axially), which show marked lignification even in the immature organ. The formation of secondary bundles takes place in such manner on the concave side that a continuous band of wood is formed here, while the xylem elements of the other side retain their individual character until after coiling. The central pith is composed of large parenchyma cells containing some protoplasm.

The basal portion differs from this in its regular oval outline, symmetrical arrangement of the xylem, heavier thickening of the collenchyma, and early formation of a continuous distinct cambium zone. Lignification has extended slightly

[13] PENHALLOW: Proc. Roy. Soc. Canada, vol. 4, sec. 4, 1886, p. 54.

to the pith, and parenchyma in the xylem, which has three or four spiral vessels besides an annular vessel in each bundle. The central pith is generally found torn apart forming the lysigenetic intercellular spaces of De Bary.[14]

The structure of the tip, however, is widely different from that of either of the regions just described. Near the extremity of the concave side may be seen the oval aperture of the cup formation lying transversely to the length of the tendril, appearing white because of the absence of chlorophyll in the tissues beneath. The cavity is .3–.4 mm. across in a direction parallel to the long axis of the tendril and about .8 mm. in a transverse measurement, with a depth of .5 mm. (fig. 6, *e*). The epidermal cells of this region become smaller toward the extremity and are smallest on the floor of the cavity (fig. 6, *a*, *a'*). The collenchyma is composed of one row of shortened, strongly thickened cells terminating at the rim of the cup (fig. 6, *b*, *b'*).

The chlorophyll layer undergoes no changes on the concave side except a slight reduction in size and an increased density of the protoplasm, a feature common to the region except certain cells near the cup. The parenchyma layer of the convex side is relatively very thick, and is composed of very angular, much distorted cells, many of which have their long diameters perpendicular to the surface as seen in fig. 6, *c*.

The bast and cambium decrease in size and disappear entirely shortly after they enter this region. The scattered bundles of xylem of the convex side and the band of the concave side converge as they near the cup and are separated only by a thin spindle of pith. The termination of the tracheary tissue is marked by a mass of epithema,[15] composed of long, slender cells with oblique ends, appearing as a continuation the tracheæ, and touching directly the epidermal layer of the cup without the intervention of the collenchyma layer.

All the tissues of the tendril are abundantly supplied with pits, especially the parenchyma of the pith and cortex, which have numerous simple pits, oval in form, arranged transversely, with the torus present. The inner side and radial walls of the parenchyma of both the concave and convex surfaces communicate with the adjacent cells by similar structures; those of

[14] Comparative Anatomy of Phanerogams and Ferns, Eng. Ed., p. 200.

[15] De Bary: Comp. Anat. of Phanerogams and Ferns, Eng. Ed., pages 375–376.

the collenchyma being most numerous on the tangential walls. The markings of fibrovascular elements are of the common form in this type of plants. The arrangement of the protoplasmic body of the organ with reference to density and composition, bears a direct relation to the sensitiveness of any part of the organ. The protoplasm is most dense and richly granular in the epidermis and chlorophyllous cells of the concave surface near the tip. The density decreases as it passes back into the middle region where it is quite uniform throughout. The contents of the epidermal cells and collenchyma of this side take the stain most deeply as does the epidermis of the convex side, which, as well as the underlying tissue, is very similar over the entire surface.

It may be assumed in conclusion, that the concentration of the protoplasm in the epidermal layer has a direct connection with irritability, that the movements of the organs are due to changes in the chlorophyll layer and that the disposition of the xylem elements is favorable to rapid flexion and extension, and that the abundant supply of reserve food material is a provision for the rapid growth and fixation of the tendril upon coiling.

Purdue University, La Fayette, Ind.

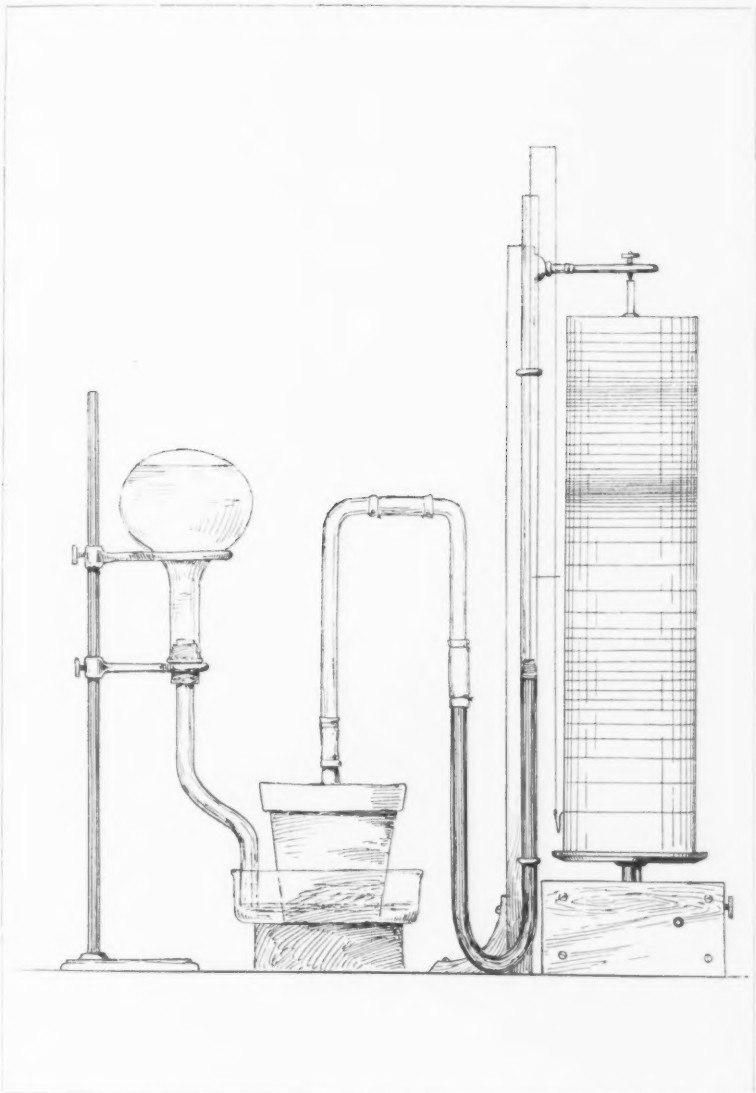
EXPLANATION OF PLATE XIV.—Fig. 1. Half cross section of middle portion of tendril.—Fig. 2. Longitudinal section of convex side of same.—Fig. 3. Longitudinal section of concave side of same. *a*, *a'*, epidermis; *b*, *b'*, collenchyma; *c*, *c'*, chlorophyll parenchyma; *d*, bast; *e*, xylem; *f*, pith.—Fig. 4. Longitudinal section of tip of tendril showing cavity, *a*.—Fig. 5. Cavity of same seen from end.—Fig. 6. Longitudinal section through tip of mature tendril. *a*—*d*, same as in fig. 1; *e*, cavity; *f*, epithema.—Fig. 7. Diagram showing distribution of protoplasm in tip and part of middle region of tendril.

An apparatus for determining the periodicity of root pressure.

M. B. THOMAS.

(WITH PLATE XV.)

The study of the periodicity of root pressure has received much attention from physiological botanists and the results of quite extended researches have been published by Sachs, Hofmeister, Detmer and others. The work has been done with very crude apparatus consisting simply of a manometer



THOMAS on ROOT-PRESSURE.

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or a glass tube attached to the stem at its base by means of a rubber tube making with it a water-tight connection. The observations were recorded by marking upon the tube each hour to indicate the rise of water in the tube or by measuring it with a scale in the glass or on a strip of paper or wood behind it. The apparatus required frequent attention and was in no sense self-registering. The other methods used were modifications of these but in all cases frequent attention was required.

The following self-registering apparatus is suggested: The base of the apparatus is about 1 by 3 feet and is supported by legs about 3 inches high. About 10 inches from one end and in the center of the base is erected a standard about 2 feet high and 4 inches in width. On the short end of the base and near the post is fastened a set of strong clock-work (the Seth Thomas "marine works" answer the purpose very well). The clock-work is covered with a box, and the end of a cylinder 6 inches in diameter and 1 foot 10 inches high is fastened to the hour pinion by means of a pin passing through a hole in the end of the pinion and fitting in a slot in the end of the cylinder. The top of the cylinder is held in place by a pin passing through a support from the main pillar, and a hole in the end of the cylinder.

To the large upright pillar is fastened a U-tube, about $\frac{1}{2}$ an inch diameter, one end being nearly as high as the pillar and the other but half the height. The tube is filled with mercury to within about an inch of the top of the short arm. The stem of the plant is cut off near the base and placed in position. An inverted U-tube is fastened to the stem in the usual way by means of a rubber tube tied with wire while the other end of the U-tube is connected to the larger one in the same way. The small U-tube is filled with water through an opening in the top.

The cylinder is made of bright tin and is blackened by revolving it slowly in the flame of a lamp or gas jet.

The indicator consists of a light steel wire with a cork at the end somewhat smaller than the diameter of the tube. This rests on the mercury. It is then at the top of the tube bent at right angles twice and allowed to extend to the bottom of the cylinder, where it is again bent at right angles and the end allowed to rest against the smoked surface of the cylinder. A pin driven in the pillar prevents the wire from turning to one side because of the friction of its end with the cylinder.

As the root absorbs water the pressure upon the column of mercury increases, causing it to rise in the tube, lifting the cork and indicator with it. The indicator then marks a continuous spiral course on the cylinder. As the cylinder revolves once each hour the hourly variation can be studied by observing the distance between the lines.

The supply of water given to the plant is kept constant by means of a flask of water supported by a stand and having an exit tube touching the surface of the water in the dish in which is placed the jar containing the plant.

The apparatus can be made in sizes appropriate for the study of periodicity of root pressure in almost any plant.

An eight day clock should be used and the apparatus need scarcely be touched until the plant is exhausted. The difference between the maximum and minimum variation will grow less as the column of mercury becomes higher but the time of variations will be the same for each day.

The apparatus described may be constructed at a very small expense and used either for laboratory experiments or lecture room demonstration. Many new and interesting problems have arisen during the investigations with this instrument and it is hoped they can be arranged for presentation in the near future.

The record on the cylinder of the apparatus shown in plate XV was made by a tomato plant. The experiment was started at 9 A. M., that being the time represented by the bottom line on the cylinder. The apparatus is represented otherwise as at the beginning of an experiment.

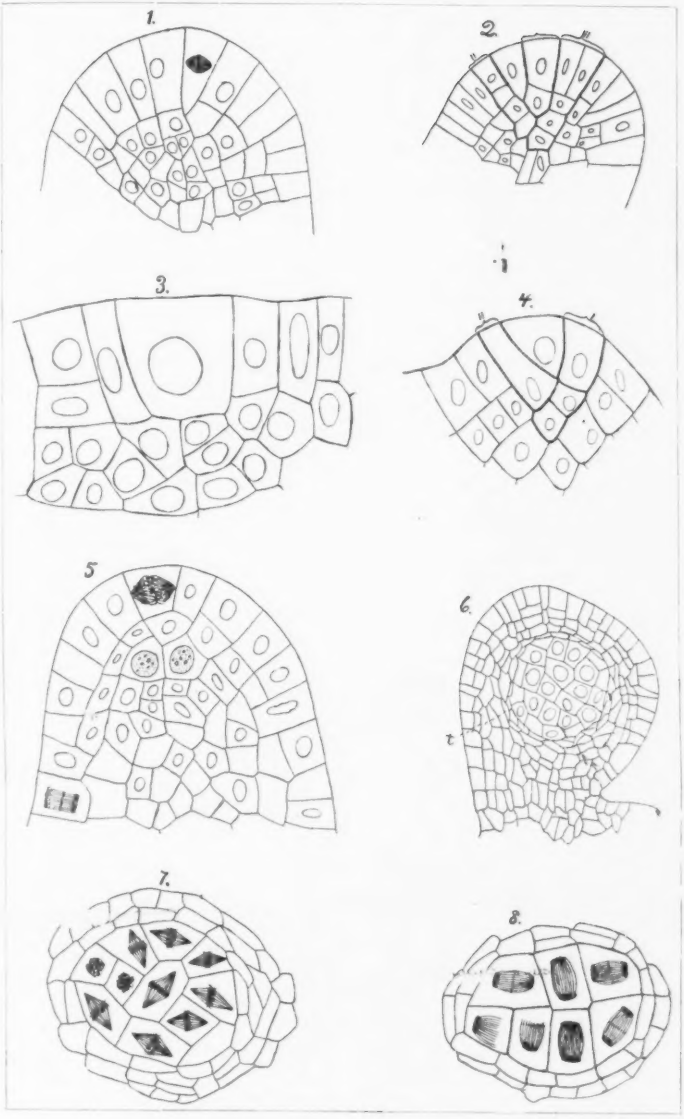
Wabash College, Crawfordsville, Ind.

On the apical growth of the stem and the development of the sporangium of Botrychium Virginianum.

C. L. HOLTZMAN.

(WITH PLATE XVI.)

The origin and affinities of the Filicineæ is one of the most important problems of systematic botany. Among investigations directed to solving this problem not least have been those concerning the origin of the Filices and the relations of the eusporangiate and leptosporangiate groups. It has been advocated by some that the Ophioglosseæ form a natural se-



HOLTZMAN on BOTRYCHIUM.

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ries, running from Ophioglossum to Botrychium Virginianum; the latter being closely related to Osmunda and through it, as the connecting link, with the Filices, forming the complete phylogeny of the Filicineæ. With this in view it was thought that if the development and mode of growth of the meristems of Botrychium Virginianum were known, it would possibly show more closely its relations to Osmunda and help to clearer views concerning the position of the eusporangiate ferns.

Dr. Douglas H. Campbell in a comparative study of the roots of Osmunda and Botrychium[1] shows that the roots grow from a clearly defined apical cell in the form of a three-sided pyramid. From the general fact that a fern grows from the same shaped cell in all parts, roots, stem and leaf, it would be expected that a cell of similar form would appear in the stem of this same plant (fig. 1). It is slightly longer than that of the root, but has unmistakably the form of a three-sided pyramid. In the stem figured the nucleus also appears in a state of division. Unless growing very slowly the segments retain their distinctness for a considerable time, often the outline of as many as three or four being easily traceable (fig. 2); while the segments follow the general rules of segmentation and divide by a transverse wall slightly below the center of the cell. The lower part may then divide into several cells by transverse and longitudinal walls; and the upper part first by a longitudinal wall into two, then each of these into two or more, thus after a time confusing the limits of each segment.

Turning now to the sporangium, we find that in the Filices proper the sporangium always arises from a single epidermal cell, which usually, according to Bower[2], projects more or less strongly beyond the surrounding tissue before segmentation begins; then a transverse wall cuts off a lower cell from which the stalk develops, and from the upper one the sporangium proper, or head of the sporangium, arises.

In Botrychium this distinction cannot be made. The sporangium is first noticed as a cell of large size (fig. 3) on the side of the pinnule in section, but not protruding beyond the other cells. The nucleus in the specimen figured, from its comparatively large size and appearance, seemed ready to divide.

[1] Notes on the apical growth of Osmunda and Botrychium, BOTANICAL GAZETTE, Feb. 1891.

[2] BOWER: The comparative examination of the meristems of ferns as a phylogenetic study; Annals of Botany, III. 362.

Three oblique walls are formed one after another, thus giving rise to a three sided apical cell. The sporangium now projects slightly (fig. 4), and in the figure probably two segments have been cut off and will be devoted to forming the stalk of the sporangium. While it is true that the sporangium arises from a group of cells, and probably some cells other than those heavily shaded (in fig. 4 those cut off from the original cell) take part in the formation of the sporangium, yet it seems equally probable that the entire sporangium can be referred to the single large cell (fig. 3). If this be true, a closer connection is shown with the leptosporangiate group than has been generally supposed. In Osmunda[3] the sporangium is not always referable to a single cell in its origin, but almost always one is noticeable as the initial cell of the young sporangium, which does not project before segmentation occurs. After the formation of the apical cell the sporangium grows to a considerable size by direct segmentation before any change is apparent. There now becomes prominent the change of the apical cell from a tetrahedral to a cubical form, from a T-division (fig. 5). Three cells, from their general shape, are evidently those which previously formed the single large tetrahedral cell. The sporangium is now probably half grown and the cell from which the archesporium and tapetum develop should make its appearance; but from the great bulk of the sporangium it would escape notice, unless it had a very large nucleus. Not until the primary cell has undergone several divisions are the archesporium cells noticeable (fig. 5). In the sporangium figured there were six of these, all very prominent from the large nuclei in them. These cells divide very rapidly, and cause the body of the sporangium to enlarge, making the distinction of body and stalk noticeable (fig. 6). The stalk is seen to be very short and thick, and the tapetum layer also makes its appearance, consisting of approximately two layers of cells. Even the oblong cell which retained the place of the initial, after the division of the tetrahedral cell, is now no longer distinguishable, each cell dividing as rapidly as possible and the whole sporangium enlarging equally in all parts. It is during the rapid division of the archesporium cells that a very interesting and previously unnoted (?) occurrence was observed, namely the simultaneous division of *all* the archesporium cells in one sporangium. In one (fig. 7) all nuclei were

[3] L. c., p. 362.

in the so-called spindle stage of division, with probably forty to fifty cells in the sporangium. Another stage (fig. 8) showed the division nearly completed, while four or five other sporangia showed their nuclei in various other stages of division.

It appears evident that the origin of the archesporium in Botrychium is more deeply seated in the tissue than it is in the Filices. This, with other characteristics of complexity of structure, according to the generally accepted view, places the Ophioglosseæ in origin as the most recent forms, in opposition to the more primitive Filices. However, it seems probable that the Filices have been a degenerating group, becoming more and more simple according to the nature of their surroundings, and thus necessarily giving rise to new forms; while the Ophioglosseæ retained their complexity and suffered no change, giving them thus the position of the more primitive forms. This we see is supported by Bower[4] with geological evidence.

The material used was fixed in one per cent. chromic acid, stained in aqueous alum-carmine, and after dehydrating, passing through turpentine and imbedding in paraffin, was sectioned on a Minot microtome; then stained on the slide with seventy per cent. alcoholic bismarck-brown to sharply differentiate the cell walls.

Indiana University, Bloomington.

EXPLANATION OF PLATE XVI.—Fig. 1. Young stem of Botrychium Virginianum showing the apical cell dividing; four segments shown. × 225.—Fig. 2. Pinnule; apical growth; outlines of three segments shaded. × 225.—Fig. 3. Portion of longitudinal section of pinnule showing origin of sporangium (large cell) × 450.—Fig. 4. Sporangium after apical cell is formed, two segments having been cut off. × 325.—Fig. 5. Sporangium in an advanced state of growth, two of the six archesporium cells shown; also the disappearance of the tetrahedral apical cell by a T-division. × 325.—Fig. 6. Sporangium nearly full grown; *t*, tapetal layer. × 170.—Figs. 7 and 8. Archesporium cells dividing, tapetal layer of two layers of cells surrounding them. × 325.

[4] BOWER: Is the eusporangiate or the leptosporangiate the more primitive type in the ferns? Annals of Botany, vol. V. no. XVIII.

Noteworthy systematic and distributional researches.

Recent work in systematic hepaticology.

For a long series of years the systematic study of Hepaticæ seemed to be held in abeyance to the settlement of various morphological problems, and the earlier activity of Nees von Esenbeck, Gottsche, Lindenberg, De Notaris and Sande-Lacoste on the systematic side came to a close midway in the fifties and was revived only by a few descriptive papers by Mitten in the sixties. Starting with the period of Hofmeister and Grönland in the fifties the study of the morphology and development of the group culminated after the preliminary investigations of Kny, Kienitz-Gerloff and Leitgeb in the masterpiece of the latter in 1881.[1] Commencing in the seventies and coming down to the present, some of the best descriptive work among the Hepaticæ has been accomplished largely by representatives of four European countries: Spruce, Pearson and Mitten of England, Lindberg (now deceased) of Finland, Massalongo and De Notaris of Italy and Stephani in Germany. The last decade especially has been prolific in new forms and the recorded number[2] of Hepatics in Synopsis Hepaticarum (1844) has been nearly doubled.

Spruce, whose masterpiece on the Hepaticæ of the Amazon and Andes, is well known, has described recently[3] thirty-four American species mostly from South America, three only being from Mexico. Jack and Stephani have described 18 new species from Peru and the United States of Columbia. Stephani has described two Hepaticæ from North America which were collected by Dr. Julius Röll, besides the Lejeuneas described in the June GAZETTE.

Asiatic Hepaticæ have been described by Lindberg and Arnell,[6] who enumerate all the known species of Asiatic Russia (96) three of which are new; and by Mitten[7] who enumerates

[1] LEITGEB: Untersuchungen über die Lebermoose, 4to, Graz, 1874-81.

[2] 1641 species: Luerssen in his *Handbuch der systematischen Botanik* (1879), curiously estimates the known species at 1300. The number will prove to be not far from 3000.

[3] Hepaticæ Novæ Americanæ tropicæ et aliæ. Bull. de la Soc. Bot. de France, XXXVI, pp. cxxxix—ccvi.

[4] Hepaticæ Wallisianæ. Hedwigia, XXXI, 11–27 (1892).

[5] Bot. Centralb. XLV, 203—4 (1891): Marchantia Oregonensis (Oregon) and Porella Roellii (Washington).

[6] Musci Asiæ Borealis, Kongl. Svenska Vet.-Akad. Handl. XXIII, no. 5, (1889).

[7] On the species of Musci and Hepaticæ recorded from Japan. Trans. Linn. Soc., Botany, III, part 3, (1891).

all the known species of Japan (74) of which thirteen are new; he also describes two Chinese Frullanias.

From Africa numerous contributions have been made to our yet scanty knowledge of the hepatic flora of the Dark Continent largely through German exploring parties. Dr. F. Stephani of Leipzig has described these, his latest papers[8] including 31 new species. Renauld and Cardot[9] publish a list of 190 species of Hepaticæ from Bourbon, Mauritius and Madagascar; a number of new species are mentioned but not described. Pearson[10] describes three new Frullanias from Madagascar.

From Australia a considerable number of species have been described in recent years by Stephani, and Carrington and Pearson, but the greatest number of novelties has been described from New Zealand by Colenso in a series of papers in the Transactions of the New Zealand Institute.

The species of the Sandwich Islands have been brought together by one of our own countrymen, Mr. A. W. Evans of New Haven[11]; 117 species are included in this list, of which five are new. Several of Austin's MS. species are also described. In addition to the species of this list 22 species were described from these islands by Mitten in Flora Vitiensis and *Anthoceros Hawaiensis* by Reichardt in 1877, thus bringing the list up to 140 species which number will be doubtless increased when some modern collecting is undertaken there.

In all the above descriptive papers, the diagnoses are full and are strongly in contrast with many of the two-line descriptions of some cryptogamic writers who have caused untold trouble by their brevity and inaccuracy. Many of the species, especially those in the larger genera, are figured.

Besides the above systematic papers we have an "Arrangement of the Genera of Hepaticae", by Mr. Evans,[12] which is highly creditable and will prove very useful. His estimates for the number of species are cautious and usually low. *Bazzania*, for instance, is credited with 100–125 species while

[8] Hepaticæ Africanæ. Hedwigia, xxx, 201—217, 265—272 (1891). Earlier papers with same title have been published by Stephani in Engler's Bot. Jahrbücher (1886), Hedwigia (1888), and Botanical Gazette (1890).

[9] Revue Bryologique, xviii, 55—60 (1891).

[10] Frullaniæ Madagascarenses. Christiania Vid.-Sel. Forhandl. 1890, no. 2 (1891).

[11] A Provisional List of the Hepaticæ of the Sandwich Islands. Trans. Conn. Acad. viii, [pp. 1—9] (1892).

[12] Trans. Conn. Acad. viii [pp. 20] 1892.

Stephani in 1886 gives a list of 169 which even then was not quite complete. The species of *Metzgeria* have doubled since Lindberg wrote his monograph which is quoted as giving eleven species. We note the absence of three of Mitten's genera, *Conoscyphus*, *Mastigopelma* and *Plectocolea*. *Cronisia* Berkeley, which Lindberg changed to *Carringtonia* because he did not believe in anagrams,[13] is also omitted from the series. So also are some of Trevisan's innovations,[14] but possibly the less said of these the better. The widely scattered literature has rendered this work by Mr. Evans specially difficult. [15] A number of generic names will have to be replaced on grounds of priority whenever we have a sufficiently stable system on which to make the shift. One hundred and seventeen genera are included, of which 87 belong to the Jungermaniaceæ. And yet the text-books persist in regarding Marchantia as a representative liverwort! — LUCIEN M. UNDERWOOD.

The psammophilous flora of Denmark.

Prof. Warming presents a sketch of the peculiar vegetation of the dunes and sandy plains in Denmark,[16] arranged according to their occurrence in the following zones: (I) "The psammophilous *Halophyta*" from the sandy strand; (II) "the vegetation characterized especially by the grass *Psamma*" from the dunes along the coast; and (III) "the *Weingærtneria*-vegetation," where this grass prevails, and which has been observed on the sandy banks along the coast or in the interior of the country.

In the first of these "formations" the characteristic is the *Halophyta*, which live here on a loose, sandy and salt-bearing soil, the surface of which is very dry and warm during certain seasons. This vegetation does not form any dense growth, since the consistency of the soil is very variable. The plants belong to two categories; annuals or perennial herbs mostly with widely creeping rhizomes, while trees and shrubs are almost absent. Among the annuals are Cakile, Salsola,

[13] Cronisia was based on *Corsinia* which it resembled.

[14] VITTORE TREVISAN: Schema di una nuova classificatione delle epatiche. Mem. R. Ist. Lomb. di Scienze e Lettere, ser. III, IV, (1877).

[15] There is needed a classified bibliography of the Hepaticae and on this we have been working for several years and hope to reach publication of the first part (author catalogue) in a few months.

[16] EUG. WARMING: De psammophile Formationer i Danmark. Videnskap. Meddel. Naturh. For. Kjöbenhavn 1891.

species of Atriplex, Senecio viscosus, Salicornia and the variety salina of Matricaria inodora. The perennials are represented by Alsine peploides, Triticum junceum, Festuca rubra, Lathyrus maritimus and the very rare Carex incurva and Petasites spuria. Only a few perennial herbs without creeping rhizomes are recorded from this locality, such as Crambe, Eryngium and Mertensia, all of the species "maritima."

What the author has called the "Psamma-formation," the second zone, includes the vegetation of the dunes which are most typically developed along the coast, where they give the landscape its very singular appearance. They are barren hills exposed to raging storms, and with a vegetation always very poor and monotonous. The plants must be able to resist a living burial in the moving sands. But as a matter of fact the formation of these dunes is actually due to their growth. *Psamma*, *Elymus* and *Triticum* make the foundation, holding the sand together by means of their roots and rhizomes; gradually a hill forms by the continuous deposits of shifting sand. When these plants have succeeded in forming the dune, others soon follow, represented by Weingaertneria, Calluna, or, in some cases, by Hippophaë, and the former growth of Psamma gradually dies out.

It is stated that a single tuft of Psamma has caused the formation of a dune about twenty meters high. This plant is, therefore, better fitted for resisting sand burial than any other. It not only does not hurt it to be covered entirely by the sand; its growth seems really stimulated, the ascending shoots stretching themselves so as to reach the surface and the sunlight.

Elymus arenarius is also a valuable plant for making stable the sand, although it is not nearly so important as Psamma, and does not seem to thrive well before the sand has been fixed. A few other grasses might be mentioned as belonging to this vegetation, namely, Festuca arenaria and some species of Triticum. The spiny, silvery-grayish shrub, Hippophaë rhamnoides, thrives here, and forms almost impenetrable thickets, due especially to its rapid propagation by root-shoots. The roots have been observed to reach a length of about five meters and to go down in the ground to a depth of about thirty cm., developing dense tufts of shoots.

The third zone is characterized by *Weingaertneria* along

with several other plants, which first occupy the soil, prepared by the "Psamma-vegetation," and which, to some extent, contribute to the stability of the sand; for instance, Sedum acre, Taraxacum, Sonchus, Leontodon, Carex arenaria, Thymus, etc. Some of them propagate by root-shoots, while others have widely creeping rhizomes, e. g., *Carex arenaria*, or runners above ground. Weingaertneria differs from these by its cespitose growth which is due to a profuse development of shoots from the axils of the lowest leaves. The young flowers are well protected by the large leaf-sheaths, as is also the case with Psamma.

There are besides these types a few others, which propagate by a multicipital root; such plants are very common in the fixed sand, and several species are enumerated.

These perennial plants have meanwhile prepared the soil for another growth which consists of annuals and biennials; but the immigration of these depends upon two conditions: the sand must have become entirely stable, and its vegetation must not be too dense.

The dune has now gradually changed its character as to soil and vegetation, and it is not seldom that it finally becomes a heath, producing a growth of Calluna and Empetrum.

Among the peculiarities of these sand plants the author enumerates and describes several singular anatomical features. It seems as if the adaptation for regulating the transpiration were the main object, and that end is gained by diminishing the leaf-surface. Several of these plants show, therefore, narrow or very short leaves; the stomata become less numerous and often confined to deep furrows or cavities, a common feature in the Gramineæ. The leaves, or their divisions, are often raised more or less vertically; a covering of hairs or wax is very common, so as to protect the stomata; while in some others a thick cuticle is characteristic. Species of succulent plants are comparatively few in number. — THEO. HOLM.

BRIEFER ARTICLES.

Living fossils.—The great flat slab on which we stood seemed built there to command a view of stoneworts.

In the clear lime water of Fall River, S. D., floated great streamers of Chara, fresh and green, yet fading insensibly, first into a dingy, then into a dead looking, and even into a stony mass, as the eye followed it up stream. It was a streamer of living, growing stoneworts that blended into the slabs of "petrified moss" strewn broadcast in the channel around us, and on one of which we stood.

But the eye could trace this so-called living fossil or petrifaction back still further to the banks overhead, where other stoneworts once floated in waters whose channel was higher than and broader than now. Yet higher still, in an earlier channel, the eye could see great slabs of it, upturned in a railroad cutting.

At our feet, where interposing boulders had reduced the transporting power of the current, a sand bar of broken stems, leaves, and whorls was lying, simply waiting for the "lapidifying juices" to cement it into limestone—a sort of puzzling Chara breccia.

Right here in reach then were all the terms of a botanico-geological stonewort series, a sort of climax, beginning with the perishable, growing plant, and capped by the same built into everlasting rocks and sands.

It only remained for the collector to make his choice, which was done, and the series exposed in a row to dry. The growing stonewort, so fresh and green, became stony, and crumbled at a touch, it was so incrusted with lime salts. So, too, the half-living, half-petrified form fell to pieces, being encrusted just enough to appear stiff and stone-like, yet not enough to last. However, slabs of the "petrified moss" of any desired linear dimensions could be had, and handled with impunity. These ever forming stonewort slabs consisted of a few inches of rigid lithified creek bed, as a stable sort of backing to the stony mat of weeds upon them.

By placing the growing stonewort immediately in glycerine it is easily preserved, and by patience, mixed with a pinch of ingenuity, the whole beautiful and interesting series of living petrifactions can be kept.—ERWIN H. BARBOUR, *University of Nebraska, Lincoln.*

EDITORIAL.

THE COMING MEETING of the American Association for the Advancement of Science is to be one of the most important of recent years so far as botanists are concerned. For that reason, if not for the pleasure of meeting other botanists and reading and hearing interesting papers, there ought to be a large attendance of botanists. The meeting is to be held in the city of Rochester, N. Y., from Aug. 17th to 24th. Reduced rates, one and one-third fare, will be granted on the usual certificate plan on all the railroads of the Central Traffic Association. The University of Rochester opens its buildings to the sections, and the usual receptions and excursions are announced.

Of foremost interest to botanists will be the proposed division of section F into two, and the formation of section G, of botany, leaving F for zoology. This question is to be discussed and settled at this meeting. In case the section is divided, the status of the Botanical Club is to be considered.

It is probable also that the proposed botanical congress in connection with the World's Fair will come before the section for discussion. The Committee which was asked by the World's Fair Auxiliary to take steps to organize such a congress recently prepared a circular letter to the botanists of the country which they vainly tried to have issued as it was prepared. It was only after long delay that it was issued at all, and on its appearance the members of the Committee were nearly as much surprised at its contents as those to whom it is addressed must be. Although the Committee may hope for some information through this inflated circular, they will expect to ascertain more of the temper of the botanists toward this scheme at the coming A. A. A. S. meeting.

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ONE OF OUR good friends writes: "I wish that the less ponderous and profound botanists were not so 'offish' in sending contributions to the GAZETTE. I like to have the work of the editors more appreciated and not sunk out of sight by over-weighty articles. . . . The *Bulletin* makes me swear . . . . ; and the GAZETTE, alas, puts me to sleep!" We almost envy the *Bulletin* this distinction; anything but being prosy! Yet it is with a clear conscience that the editors print this accusation against the "less ponderous and profound botanists;" it does not lie against the editors.

We have so often urged the "small fry" (as another friend calls this class in which we all claim to rank) to send notes and items regarding their work, that we are blameless. Not only has the invitation been pressed, but the most ample provision has been made for these shorter articles.

When the departments of the GAZETTE were differentiated, "Briefer Articles" was established to receive communications of less than two pages. Later "Open Letters" was provided for those who chose to put items of interest, discussion or criticism into this form. And for the briefest, "Notes and News" is always waiting.

The GAZETTE does not print all MSS. which are sent to it. But we can truthfully say that no communication was ever rejected because it was too short or would interest only amateurs. On the contrary we welcome the notes by amateurs for amateurs, and lament the decrease of "briefer articles."

CURRENT LITERATURE.

The Myxomycetes of eastern Iowa.

The leading paper of the latest number of the *Bulletin* of the laboratories of natural history of the State University of Iowa [1] is a descriptive catalogue of the myxomycetes of eastern Iowa, by Prof. T. H. McBride. Sixty-six species are described, and most of them are beautifully figured on the ten plates drawn by Miss Mary McBride to accompany the monograph. Incomplete as it may be for its own locality and for others further removed, there are many botanists who have desired to know something of the group who will welcome this work, and will thank its author for the care and labor he has expended in its preparation. We trust that it is only preliminary to a fuller and more elaborate account of the species of the upper Mississippi valley. We suggest as an improvement for the next edition, that the author carry his "keys" further, to include the species of the larger genera, such as Trichia and Physarum. It is a help to the beginner, out of all proportion to the labor it costs the author, to have some clue to the species, after he has been led by keys to the genus.

The Missouri Botanical Garden.

The third annual report of this institution was issued about the first of June. The report of the director, Dr. William Trelease, is most interesting to those who are watching eagerly the progress of the garden, for it summarizes the improvements of the past year, certainly one of the most active since its organization. Besides the necessary work of maintenance, many repairs and improvements have been made. They have included excavating and remaking in a substantial manner many of the walks; extensive draining; resetting of edging for

[1] Vol. II, no. 2, pp. 99—162, pl. 10.—June 1892.

the beds; replacing all the sets of steps about the parterre; rebuilding from the foundation the west wing of the greenhouse and repairing it throughout; replacing unsightly and dilapidated wooden fences with open wire or iron ones; beginning to put the fruticetum into order by removing some of the old and useless trees, subsoiling about 5 acres, spading about one acre of it from two to two and a half feet deep, and planting a small orchard and a considerable number of shrubs. In addition to the introduction of many plants brought from the West Indies by Mr. Hitchcock, a very successful attempt has been made to introduce hardy native species into the grounds. About 1500 species were planted under the direction of Mr. F. H. Horsford; a bog and artificial pond and many small beds having been prepared in the arboretum. The trees are being labeled with white-bronze plates bearing the name in raised letters, while white celluloid labels have been found best for the herbs. The Engelmann and Bernhardi herbaria have been mounted and arranged. They contain about 155,000 specimens. Dr. Trelease has also donated his private collection, chiefly of fungi, containing about 11,000 specimens, and his library of 500 books and 3000 pamphlets. Mr. Shaw's city residence has also been taken down and rebuilt in the garden, in accordance with the directions in his will. It is now occupied by the herbarium and library, for which it at present forms commodious quarters. In rebuilding, it was made fireproof. The library now contains about 6,000 volumes, and receives a large number of exchanges.

This is truly a record of remarkable activity, and augurs well for the future. All that is done, is being done with reference to perpetuity and permanent value, a policy that cannot be too warmly commended.

Though so much foundation work is being done, immediate results in scientific lines are not lacking. The report contains a thoroughgoing revision by Dr. Trelease of the 21 American species of Rumex, illustrated by 21 full page plates; a complete recapitulation by Dr. C. V. Riley of the observations on the Yucca-moth and Yucca-pollination, together with descriptions of the species of Pronuba and its allies, illustrated with 10 plates: notes and observations on the species of Yucca, hy Dr. Trelease, illustrated by 23 plates; a description by Dr. Trelease of *Agave Engelmanni*, n. sp., with plate; and finally a short paper by Thos. A. Williams on the fruit of *Parmelia molliuscula* Ach., a lichen whose apothecia, hitherto unkown, were discovered by Mr. Williams on a specimen in the Engelmann herbarium.

In such a foundation for research, and in these early results, American botanists may feel a just pride!

The principles of agriculture.[1]

Under this title Mr. Winslow seeks to set forth the elementary principles of chemistry, physics, geology and biology so far as they affect domesticated plants and animals. We have nothing to say of the parts of the book other than the botanical, further than this, that they seem to be of about the same quality. In the physical chapter, for instance, we notice a tranverse section of a woody stem used to illustrate the "porosity of matter"! The chapter on plants wholly ignores the existence of any but the flowering ones. The consideration of these almost begins with the hoary yarn about the germination of seeds from the hand of an Egyptian mummy 3,000 years old. And what follows is not materially better. The embryo of the bean is said to be located at the "eye"; "seeds *are supposed* to contain a supply of nourishment sufficient to support the young plant until the ascending stem can reach the open air"; "a *shoot* called the radicle extends downward"; "the radicle is the origin of the roots of plants"; these are some sentences from the paragraphs on seeds. Mr. Winslow gravely argues that the directive force for the stems and roots cannot be light "as it has been found that the same directions are followed when a seed is sprouted in darkness." He therefore concludes that plants are "endowed with a kind of instinct similar to the instincts of animals." Heliotropic and nyctitropic movements "we cannot account for with certainty, in a scientific way."

The rise of the "sap" is due to "capillary attraction." The "material of the roots has a very strong attraction for water" so that the water is drawn up with considerable force, so much in fact that that "this force is sufficient to assist in the extension of buds and leaves in their growth. It is supposed to explain also the tall slender growth of crops in a wet season", in which case the author suggests that the plants are forced "out of their normal dimensions"!

Oh for a writer on elementary science who has some knowledge! However it may be in religious experience, it has been abundantly demonstrated that in science, out of the mouths of babes and sucklings praise has *not* been ordained.

Minor Notices.

Mr. Theo. Holm has prepared the "Third list of additions to the flora of Washington, D. C.", which has been published by the Biological Society of Washington.[2] About 80 species and varieties have been

[1] Winslow, I. O.— The principles of agriculture for common schools. Large 12mo. pp. 152. Chicago: The American Book Co. 1891.

[2] Proc. Biol. Soc. Wash., Vol. II, pp. 105—132.

added since the last supplement by Knowlton in 1886. Numerous new localities are also given.

In 1868 Dr. G. L. Goodale published a list of the phanerogams of Maine, which has generally been known as the "Portland Catalogue." A second edition of that list has now been prepared by Mr. M. L. Fernald, [1] of Cambridge, Mass. The list incorporates the discoveries since 1868 and by marks gives some indication of the distribution of plants in the state. Mr. Fernald proposes a complete annotated catalogue later, and asks assistance particularly in the collection of cryptogams.

In a recent paper in the *Proceedings* of the California Academy of Sciences [2] Dr. Douglas H. Campbell gives a detailed account of the structure and development of the prothallium and embryo of Marsilia vestita.

A second edition of Webber's "Appendix to the catalogue of the flora of Nebraska" has been issued by Dr. Charles E. Bessey of the University of Nebraska.[3] In addition to the correction of a few minor errors and the rearrangement of the index there is a supplementary list of recently reported species by Dr. Bessey.

Two papers on the Hepaticæ have recently been distributed by their author, Mr. A. W. Evans.[4] His "Arrangement of the genera of Hepaticæ" is an attempt to bring together the genera of these plants which are best entitled to recognition into natural groups, with a citation of the place of original publication and the chief synonymy. It will doubtless be of use to students of this group. The other paper is "A provisional list of the Hepaticæ of the Hawaiian Islands" and is based upon collections made by D. D. Baldwin in 1875–6 as determined by Austin. Ten new species are described and figured, of which five are credited to "Austin MS."

The forest trees of Indiana are enumerated by Prof. Stanley Coulter in a pamphlet reprinted from the Transactions of the Indiana Horticultural Society for 1891. One hundred and eight species are found in the state. Concerning these Mr. Coulter has gathered much valuable information from his own observation, from MSS. material placed at his disposal, and from previous publications on the plants of the state, particularly as regards their distribution and economic importance.

[1] Proc. Portland Soc. Nat. Hist. 1892.

[2] Second series, vol. III, pp. 183—205, plate iii. April 19, 1892.

[3] Contributions from the Botanical Department of the University of Nebraska, new series, III. June 14, 1892.

[4] From Proc. Conn. Acad. Sci., vol. VIII.

OPEN LETTERS.

Pink and yellow pond-lilies.

Pink pond-lilies are very commonly sold in Providence at the card store of Mr. E. C. Davis. Correspondents can always purchase them here in good shape. What I write to record, however, is the presence now, in the same shop, of a bunch of these lilies which are of an exquisite shade of pale *yellow*. I never saw anything like them before. Both kinds come from Cape Cod. We used to have, according to George Thurber, a locality for the pink ones near Providence; it has long since vanished.

Mr. J. F. Collins has found *Lotus corniculatus* here.—W. W. BAILEY, *Providence, R I.*

NOTES AND NEWS.

Two forms of registering apparatus for studying transpiration are described by Messrs. Taylor and Frost.

THE MAY number of the *Student* opens with a sprightly sketch of Julius von Sachs by Mr. Hubert M. Skinner.

THE TWO PAPERS of botanical interest in the June number of the *Forstlich-naturwissenchaftliche Zeitschrift* are "the quality and structure of fir wood," by Dr. R. Hartig and "the influence of elevation on the temperature of the soil," by Dr. E. Ebermayer.

A LUCID SUMMARY of our present knowledge of the nature and origin of fecundation both in the plant and animal world is to be found in the February and April numbers of the *American Naturalist.* It is the text (and illustrations) of a lecture delivered by Mr. H. J. Webber of the Shaw School of Botany before the Alumni Association of St. Louis Medical College.

HERR AMM, under the direction of Prof. Detmer, has conducted a series of experiments on the intramolecular respiration of plants, by which he has demonstrated the direct dependence of this sort of respiration on temperature, and on the stage of growth of the plants. It increases up to the optimum temperature for normal respiration, and also with the age of the seedlings, up to nine days.—See *Ber. d. deutsch. bot. Gesells.*, vol. x ,heft 4.

A PRIZE of a thousand marks is offered by the Experiment Station of Middle Java for the best investigation on the causes and prevention of the disease of Sorghum which is characterized by the reddening of the fibrovascular bundles. The limit of time for the investigation will be announced later. Manuscripts have to be written in German, and the usual precautions for withholding the name of the writer from the committee of award are to be observed.

THE WISCONSIN ACADEMY of Sciences, Arts and Letters held its field meeting for 1892 at Ripon, Wis., on June 2—4. The plans of the committee regarding out-door work were completely blocked by the steady

rains. A preliminary paper on the flora of Dane county, Wis., was presented by Messrs. R. H. True and L. S. Cheney of the University of Wisconsin, and Prof. C. R. Barnes delivered the public address in the Ripon College Chapel on "Asa Gray."

DR. J. C. ARTHUR publishes in the May number of *Agricultural Science*, a paper read before the Society for the Promotion of Agricultural Science at its Washington meeting, on the physiological basis for the comparison of potato prudction. He concludes that to make fair comparisons the seed material must be of the same weight, roughness and number of pieces; and that if the tuber is divided, only the same regions of the same weight tubers are comparable.

W. C. SHANNON, Asst. Surg. U. S. A., as member of the Central Division of the Intercontinental Railway Commission has collected specimens of the natural history of the various regions of Guatemala embraced in the surveys of the Commission. Capt. M. M. Macomb, U. S. A., Engineer in charge, has turned over the entire botanical material to Mr. J. Donnell Smith for elaboration, and for distribution to the chief herbaria. These plants will accordingly form part of the extensive series entitled, *Ex Plantis Guatemalensibus quas edidit John Donnell Smith.*

AT THE LAST commencement of the University of Wisconsin two of the theses presented were of botanical interest. Mr. A. M. TenEyck read an honor thesis on the "Regermination of seeds." Mr. Ten Eyck has carried out a long series of experiments to determine the number of times seeds of various garden and field plants could be made air-dry without destroying their vitality. Some, notably the cereals, will stand an astonishing amount of this hard treatment, growing after as many as 12 desiccations.[1] For the degree of M. S., Mr. Rodney H. True presented a thesis "On certain species of the so-called orthocarpous Dicrana." This will be published as part of a revision of the Dicrana in preparation by Messrs. Barnes and True.

THE PROGRAM of the international botanical congress, to be held at Genoa between the 4th and 11th of September, 1892, has been issued. Sunday, Sept. 4, is devoted to a reception of the foreign botanists. Various excursions are planned during the week. All the sittings of the congress will be public. The official language will be Italian, but it will be free to everybody when speaking or in discussions to use whatever language he may be most familiar with. It was not considered advisable to fix any special subjects for discussion, but it is announced that the reform of botanical nomenclature will be treated in accordance with O. Kuntze's recent book! After the congress, the committee will print a brief account of the meetings and will publish also the original memoirs.

PAUL SCHOTTLÆNDER has found that the same differential standing of the sexual cells of plants is possible as Auerbach has demonstrated in the sexual elements of anamals. Sections of the prothallium of *Gym-*

[1] In the May number of the *Revue gen. de Botanique* M. Gaston Bonnier records some similar but much less comprehensive experiments on the revival of seedlings after complete desiccation.

nogramme chrysophylla showing both antheridia and archegonia were double stained by Rosen's method, which will be described in the next part of Cohn's Beiträge zur Biologie der Pflanzen. Under this treatment the bodies of the spermatozoa are colored intense blue, while the plasma and nucleus of the egg cell are red. We see possibilities of material aid in determining the homologies of the embryo sac structures by this process. Schottländer's paper is only preliminary to fuller researches and publication.

THE FIRST REPORT of the director, Prof. F. H. Snow, of the temporary station of the University of Kansas, which was established "to promote and conduct experiments for the destruction of chinch-bugs by contagion or infection," has recently been issued, and forms an octavo volume of 230 pages, with plates and map. There are three diseases of chinch-bugs studied by the station: the white-fungus disease caused by Sporotrichum globuliferum, the gray-fungus disease caused by Empusa aphidis, and the bacterial disease caused by Micrococcus insectorum. The fungous diseases thrive in damp weather and the bacterial disease in dry weather. In 1891 three-fourth of the attempts to artificially carry infection were successful. Reports were received from 1400 farmers.

THE INTENSITY of the breathing process in plants which thrive in shade compared with those which require full exposure to sunlight has been investigated by Adolf Mayer (*Landw. Vers. Stat.*, XL, 203). For one class he used house plants, such as Tradescantia zebrina and Saxifraga sarmentosa, and for the other class field plants, such as rye. The leaves of the house plants took up much less oxygen in the same time, than those of the field plants as compared either with their living volume or dry weight. From this he concludes that plants which thrive in the shade, while unable to assimilate as much nutriment as others for want of sufficient light, yet are able to provide the same excess by reason of the lower intensity of the oxidation processes.

WILHELM RAATZ describes and figures, in the Berichte der deutschen botanischen Gesellschaft x. 183, the tyloses which he has discovered in the tracheides of species of conifers. In the same journal (vol. vii) Conwentz had declared the existence of such structures in the wood of the trees producing amber. But Raatz holds that this rests on a false interpretation of the structures seen and that the true tyloses are now for the first time figured and described. They are quite similar to the same structures in the angiosperms but are much less common, apparently arising only in the wood near a wound; as if the energetic radial division of the cambium to cover a wound spread to the neighboring tissues.

THE HOPKINS SEASIDE LABORATORY, a department of the Leland Stanford University, has been located at Pacific Grove, California, and will hold its first session of five weeks, commencing June 27th, during the present summer. Pacific Grove is a sea-side resort on the southern shore of Monterey Bay, two miles west of Monterey, and the seat of the Pacific Coast Chautauqua Assembly. Through the generosity of the Pacific Improvement Company, a piece of land has been furnished, and a sum donated sufficient to erect a plain frame building; and by

the liberality of Mr. Timothy Hopkins provision is made for the equipment of the building, and for the future continuation and extension of the enterprise. The library and apparatus of the University laboratories will be used.

An elementary course in marine botany will be given by an assistant selected by Dr. Campbell, as the engagements of the latter will prevent his being present during this season.

IN THE *Annals of Botany* for April Mr. W. A. Setchell presents the results of his examination of the species of the genus *Doassansia.* He recognizes 12 species, of which two, *D. obscura* and *D. deformans*, are new, occurring on the stems of Sagittaria variabilis in Massachusetts and Connecticut. Two new genera, *Burrillia pustulata*, in honor of Dr. T. J. Burrill, and *Cornuella lemnae*, in honor of Prof. M. Cornu, are also described, the former from Illinois and Wisconsin and the latter from Massachusetts. In the same number, Dr. D. H. Campbell discusses the prothallium and embryo of *Osmunda* and suggests the bearing of the observed facts on the phylogeny of the ferns. Bacteriologists also will be specially interested in the article of Mr. H. M. Ward on the characters or marks employed in the classification of the Schizomycetes, at the conclusion of which he suggests the questions which should be answered by bacteriologists before they publish a species as new. These relate to habitat, nutrient medium, gaseous environment, temperature, morphology and life history, and special behavior.

THE UNIVERSITY of MINNESOTA has begun the publication of a *Quarterly Bulletin* under the editorial management of Prof. Conway MacMillan, and the direction of a board of editors appointed from the various faculties of the University. The following items of botanical interest are taken from the first number:

Work upon the botanical survey of the state is being pushed with vigor. Three collectors last season brought in more than 20,000 plants, covering in their exploration pretty thoroughly the valley of the Minnesota. This season four collectors are in the field. It is the intention to gather largely for exchange, with a view to strengthening the herbarium in plants of the southern hemisphere. The collectors will give special attention to the fungi, lichens and algæ.

Dr. Albert Schneider has in press in the Minnesota Academy a paper criticising Jumelle's researches on the influence of anesthetics on transpiration. (See this journal XVI, p. —.) His experiments lead him to the conclusion that ether *retards* transpiration by retarding assimilation, under all conditions. Jumelle's results were faulty in the use of parts only of plants and in confounding evaporation with transpiration. The increased loss of water vapor from anesthetized vegetable tissue is due to the alteration of the primordial utricle by the ether, allowing evaporation to take place.

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